Herd Monitoring and Information Analysis

If you can't measure it, you can't manage it.

Corollary: If you aren't measuring it, you aren't doing as well as you think you are.

More is missed from not looking than from not knowing

The faintest pencil is stronger than the strongest mind

Corollary: In God we trust; all others must provide data. (W. Edwards Deming)

Overview

Because computerized herd monitoring and information analysis is relatively new, it and the veterinarian's role are evolving. Applying computers to herd information began in two areas. As part of the emergence of artificial insemination in the 50's, the USDA established the Dairy Herd Improvement Association (DHIA) to calculate the genetic merit of bulls by using central mainframes to analyze mailed-in production data. When large commercial feedlots emerged subsequent to the development of the IBR vaccine in the 60's, they began using minicomputers to track the performance of pens of cattle. As breeding herd size increased in the swine industry, detailed production accounting systems such as Swine Graphics emerged to improve production management.

With the emergence of the personal computer subsequent to the development of integrated chips in the late 70's, computer processing power became much more affordable and these systems moved from central processing facilities to the farm. When herds size increased beyond what fit on a breeding wheel, managers needed "list generators" to track individual animals and to generate lists of what animals needed moved, vaccinated, checked or culled as they moved through the production cycle. Previously, managers in could remember enough information about each individual in the small herd or in moderate-sized herds they kept simple paper records, calendars and breeding wheels to track animals through their production cycle. PigCHAMP was one of the early on-farm systems in the swine industry and DairyComp305 was one of the early on-farm systems in the dairy industry, both developed primarily by veterinarians. Because new measuring systems, such as BouMatic StepMetrix, new data capture technologies, such as wifi-connected handhelds, and new scoring systems and management strategies are continually emerging, veterinarians need to understand the benefits, the costs and the pitfalls of data collection and management.

Purposes of Data Collection, Monitoring and Analysis

1. Detect deviation from expected performance
   - Requires sound basis for comparison
     - Industry Performance Benchmarks (see references below)
     - Historical performance
       - Previous group performance
       - Previous season for seasonally affected production system
       - Previous similar groups
     - Performance of similar herds in area
     - "Rules of Thumb"
       Ex: Proportion of cows that should be laying down chewing their cud in a freestall facility if adequate cow comfort is present

2. Detect systems that are going out of control
   Because cows (and people) are creatures of habit, the producer's goal is to minimize variation and maximize consistency
   - The reason for creating standard operating protocols (SOPS), training employees to use these, and monitoring for "procedural drift."
   - Your goal is to detect the real signal of an oncoming problem as early as possible
     - Problems detected earlier are usually easier and less expensive to correct than problems that have had longer to develop
   - Your problem is balancing sensitivity (early detection of true signal of a problem) with specificity (minimal false alarms)
   - Requires regular data collection to establish time series and control bounds for alert and action

   Statistical quality (process) control is a special area of statistics with phrases such as Shewhart control charts, CuSum charts, Six Sigma, Total Quality Management, Deming PDCA Cycle and names such as W. Edwards Deming and Walter Shewhart
   (For background and application, see papers and chapters authored by Reneau and colleagues in References)
3. Solve production problems
Investigations - Determine what events or factors are associated with a problem so that it can be prevented in the future (see “Herd Problem Solving,” “Herd Problem Investigation Resources for Veterinarians” and “On-farm Studies: Methods for design, execution and analysis”)

4. Motivate producers
Peer group performance comparisons on key measures are a powerful motivator among elite producers ("yours is herd C in this 24 peer herd bar chart of <a key production measure>"). John Day, Swine Graphics

Value of information vs. cost of data collection and analysis

1. Producer has to believe that the information from monitoring has sufficient value to justify investing scarce resources in collecting, entering and storing the data on a routine basis or for paying someone else to do it.
   - Producer action horizon is usually shorter than the veterinarian's
   - Producer is usually collecting data to facilitate daily day-to-day management
     List generation - What cows to move where when or do what to who.
2. The veterinarian must minimize data collection cost, efficiently summarize it and effectively present actionable information in a timely manner.
   - Become a spreadsheet maven – graphs (charts), cross tabulations (pivot tables), data selection and manipulation – and then teach the process to an employee (see the Schmuller book in References as an example text)
   - Know efficient strategies that can be adapted to fit into the producer's current system and that can be performed to acquire key measures at critical times
     Ex: BCS scoring using handheld-based data capture during routine handling or during “point-in-time” walk-through or drive-through at critical times, such as at dry-off for dairy or beginning of third trimester for cow-calf
   - Use other existing data flows that aren't tracked as secondary data in the absence of primary data
     Ex: Receipts for trucking to establish feed flow
   - Utilize trained technicians to reduce labor cost but maintain performance in data collection and analysis (Dr. John Day)
   - Hone applied barnyard epidemiology skills to minimize time required and maximize validity of conclusions
     Know how to define and establish risk cohorts of animals
     Know what causes bias in results and how to minimize it
     Know how to carry out valid clinical trials in clients herds
   - Automate the data analysis as much as possible through basic programming
     Scripts for DC 305 Consultant
     Macros for Microsoft Excel

Strategies

1. Continuous monitoring - every batch or individual fed, or produced or measured
   Ex: Bulk tank milk shipment weights, processor milk component analyses, dry matter intake (EZ-Feed), rectal palpation results
2. Repeated monitoring
   Ex: Monthly individual cow milk yield and component testing (DHIA)
3. Cross-sectional monitoring
   Applied at one point in time for selected animals in different points in the production cycle
   Ex: "Snapshot" dairy body condition scoring
   Note that this often requires the assumption that the animals longer in the production cycle followed the same trend as animals earlier in the production cycle currently represent.
   Applied at one time in production cycle to a group
   Ex: Body condition scoring of beef cows one month prior to start of calving
4. Linked - "If pattern 'X' appears and measure “Y” is out of line, then dig deeper to look at 'Z'"
   Higher aggregate measures to deeper more specific measures
   Easy, low cost measures to harder, more expensive measures
   Ex: Body condition score, milk fat test to NEFA’s
Management Information Product

Plots - "A picture is worth a thousand words"

- Know how to efficiently generate and manipulate scatter plots and pivot tables (cross tabulations) in Excel or other spreadsheets
  - Including the right data series
  - Adding smoothed trendlines to see patterns over time in “noisy” data

One sheet of summary information followed by detailed supporting information

- Fully detailed reports are difficult to handle and are overwhelming to those unfamiliar with the reports or the process
- Start with the simple but important and move to the complex as needed

System Monitoring - to generate information from data that is quantitative in its initial form

Examples:

Dairy (see Wisconsin FAPM website for a collection of forms and guides):
- Colostrum quality monitoring –
- Dry cow urine pH monitoring
- Fresh cow monitoring
- Heifer Girth measure
- Housing assessment
- Ketosis testing
- Milking system function - vacuum reserve recovery, pulsation pattern
- Pasteurizer monitoring
- Ration dry matter
- Serum for passive transfer efficacy in calves
- Somatic Cell Count - Bulk SCC, CMT
- Ventilation Assessment
- Milk Quality – CIP monitoring, mastitis culturing

Beef:
- Late gestation BCS
- Beef herd calving dates for calving distribution

Scoring Systems - to generate information from data that is qualitative in its initial form

Convert subjective assessments to quantitative data for tracking and comparison

Scoring system needs to be soundly evaluated prior to use

- Is it measuring what it is supposed to measure?
- Strong predictive relationship with an important variable
  - Needs to be a "Critical control point"
- Valid between observers and repeatable for same observer

When should it be done for the most good?

- Preventive - sufficient time to intervene to prevent the problem
  - Ex: Body scoring beef cattle in mid-gestation
- "Post-mortem" - prevent the problem from occurring again next year
  - Ex: Body scoring first calf heifers at breeding time to explain "sophomore slump"

What are the opportunities for piggybacking it on something else that is already being done?

- Ex: Body condition scoring beef cows at fall preg check

Dairy examples:

- Body Condition Score
- Lameness Scoring
- Manure Scoring
- Ration fiber - Penn Particle Separator (Forage Box)
- Sanitation Scoring
- Teat end Scoring
Precautions and Problems:

1. Failure to appreciate the interlocking, inter-related dynamic nature of a farm’s systems

Production units are comprised of systems (e.g., labor, crops, youngstock rearing, breeding herd, housing, feed storage, waste storage, machinery) in which the outputs of one are inputs of others and changes in one adversely affect others.

EX: The labor demands of a serious calf scours outbreak diverts already scarce labor from other critical activities, resulting in a performance drop in those areas that shows up later in an indicator.

Change is constant – seasons, new feed batches, weather events, prices.
Poorly designed systems cannot be controlled.

2. GIGO - Garbage in, garbage out

Remember, “In God we trust; all others must provide data.” If at all possible, don’t rely on perceptions or memories. People’s memories are biased, recalling the most dramatic, the most recent, the most unexpected.

When using data from record systems, you must check the quality of the input data.

Quick data quality checks

Logical consistency - Does this value make sense?
- Use spreadsheet date calculations to determine gestation length and days open from prior calving date, breeding date and current calving date.
- Use spreadsheet Sort function to screen minimum and maximum values.

Avoid deadly but hard-to-detect spreadsheet induced errors (e.g., number formatted as text, range errors, cell reference errors) by using more robust design techniques.

3. Dangling Numerator for Risk

Risk is the number of events in a group over a defined period (numerator) divided by the number of animals at risk of that event in that group during the period (denominator).

Event counts are easy to get; the number at risk (denominator) is harder to get.

- No. of DA’s in a period vs. the number of cows at risk of a DA in that period
- Time interval in which high risk occurs
  - 0 to 30 DIM?
- Risk factors associated with that risk
  - Multiparous cows vs. primiparous heifers

The count of an event with constant risk will go up and down in parallel with the change in number of animals at risk of that event in a group even if the risk of the event is constant.

Including animals not at risk of the event in the denominator underestimates the true risk.

4. Missing Animals

Any measure can be made to look good by either getting rid of the failures (culling, dying) or otherwise omitting them from the analysis.

- Is the reproduction information from cull cows included in evaluating reproductive performance?
- Are deads or opens included in analyzing production?
- Does the production program include data from animals lost from the cohort being analyzed?

If some of it is “censored”, truncated or missing from more than a small percentage of individuals, use nonparametric summary statistics appropriate for that type of data.

- Survival curves, median time to status change (e.g., DIM to pregnancy) rather than means or averages.
- Median days open rather than average days open.

5. Noise from natural variation in small numbers vs. time

How many do you need to accumulate to obtain a reliable picture of what is going on?

How long do you do you accumulate numbers?
- Too long - How much else changed during that period?
- At what point is a deviation of sufficient magnitude that the money and time spent looking into it is justified?

Shewart control charts, Q-sums.

6. Definitions

"Hidden" definitions.
What is the program calculating internally? What animals does it include or exclude? These are not consistent across software programs!

Changing definitions over time or different definitions between comparison groups
Different producers and programs use different definitions for cases

7. Using the wrong measure
In complex systems a combination of factors often impact a measure with different factors having different leverage and falling with the responsibility of different individuals. An example is holding the calf treatment crew responsible for calf morbidity and mortality on a custom calf raising operation when they have no control over colostrum status and the feeding crew is rewarded for minimizing feed costs but not calf performance.

8. Other Pitfalls
Tyranny of the group summary (aggregate) measure vs. the individual
Individuals in the tails are the ones to which most attention should be paid because that is where both the problems and opportunities lie.
Group scale weights disguises the lack of uniformity in weaned calves
Momentum and Lag
Changes in some measures occur long after the biological change occurred
Ex: Calving interval as a measure of reproductive performance lags by gestation length
Acute vs. chronic
Because of their longer duration, in cross-sectional monitoring chronic cases will be over represented and short duration acute cases will tend to be under represented.
Bias of the average vs. the median or percentiles
Ex: English majors in one Ivy League school's graduating class averaged $60K starting salaries.

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